Original Article

Comparative evaluation of the efficacy of curcumin gel with and without photo activation as an adjunct to scaling and root planing in the treatment of chronic periodontitis: A split mouth clinical and microbiological study

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Abstract

Aims and Objectives: Harnessing Mother Nature's bountiful remedies for rejuvenation has been in vogue since time immemorial. Turmeric contains the polyphenol Curcumin in its rhizome. It produces reactive oxygen species (ROS) with visible light irradiation as photodynamic therapy (PDT) - which validates its use in the treatment of periodontitis. This study compares Curcumin and Curcumin PDT as an adjunct to conventional Scaling and Root Planing (SRP) with SRP alone in the treatment of patients with chronic periodontitis. **Materials and Methods:** Sixty sites in fifteen untreated chronic periodontitis patients were randomly assigned in a split mouth design for one of the treatment modalities; 1) Scaling and root planing (SRP) alone, (2) SRP + Curcumin application for 5 min, (3) SRP + Curcumin application for 5 min + irradiation with blue light emitting diode of wavelength 470 nm for 5 min. (Curcumin PDT) on "0" day.(4) SRP + Curcumin PDT on 0, 7th and 21st day. The clinical parameters included plaque index (PI), bleeding on probing (BOP) measured by sulcus bleeding index (SBI), probing pocket depth (PPD), clinical attachment level (CAL) recorded at the baseline & 3rd month. The site with greatest probing pocket depth (PPD) was selected from each quadrant for bacterial sampling and culturing for *Aggregatibacter actinomycetemcomitans (Aa)* and other black pigment producing microorganisms (BPB) *like Porphyromonas gingivalis & Prevotella intermedia*. **Conclusion:** The present study showed that Curcumin photodynamic therapy is a valuable treatment modality adjunctive to conventional scaling and root planing over Curcumin application. Moreover, multiple adjunctive applications of photodynamic therapy are more beneficial than single application in reducing clinical & microbiological parameters.

Key words: *Aggregatibacter actinomycetemcomitans*, black pigment producing microorganisms, chronic periodontitis, curcumin, photodynamic therapy, reactive oxygen species, turmeric

INTRODUCTION

Turmeric (*Curcuma longa*) which is extensively used as a spice, food preservative, coloring material, and household remedy[1] is emerging as an alternative treatment option for periodontal diseases. Curcumin (diferuloylmethane), the

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main yellow bioactive component of turmeric has wide spectrum of biological activity including anti-inflammatory, antioxidant, anticarcinogenic, antimutagenic, anticoagulant, antifertility, antidiabetic, antibacterial, antifungal, antiprotozoal, antiviral, antifibrotic, antivenom, antiulcer, hypotensive, and hypocholesteremic activities.[2-10]

The anti-inflammatory properties of curcumin are mediated by modulation of the activity of signaling pathways and transcription factors, especially nuclear factor-κβ (NF-κβ), activating protein-1 and mitogen-activated protein kinases (MAPKs).[11] Down-regulation of the activation of and MAPKs by curcumin suppresses the expression of interleukin-6 (IL-6), IL-1β, tumor necrosis factor-α, matrix metalloproteinase 2 (MMP-2), and MMP-9 in NF-κβ in the late phase of experimental acute pancreatitis[12], in the modulation of arthritis[13-16], in the prevention and healing of indomethacin-induced gastric ulcer,[17] and in the treatment of inflammatory bowel disease and Crohn's disease.[18-20] Curcumin is also reported to improve wound healing by increasing collagen deposition, angiogenesis, and the density of fibroblasts.[21] Interestingly, curcumin-treated wounds presented not only a greater number of fibroblasts but also more infiltrating macrophages and neutrophils compared with untreated wounds.[22,23] The better regulation of granulation tissue formation by curcumin and induction of growth factors,[23] are key features, which can be extremely useful in the therapy of periodontal disease.

Photodynamic therapy (PDT) is used in the treatment of cancer and other nonmalignant diseases.[5,24] PDT involves the use of a photosensitizer (PS) that is, activated by exposure to light of a specific wavelength in the presence of oxygen. The excited PS binds to the target cell and induces the formation of reactive oxygen species (ROS), causing localized photodamage and cell death.[7,25] One advantage of PDT, when compared to antibiotics, is that bacteria do not develop resistance to ROS. An ideal PS should be nontoxic and should display local toxicity only after activation by illumination.[28] Curcumin with wide therapeutic applications[29] has proved be biologically safe and has a broad absorption peak in the range of 300-500 nm (maximum ×430 nm) with potent phototoxic effects in micromolar concentrations. Indeed, the PS effects of curcumin are reported to be beneficial in the treatment of localized superficial infections in the mouth or skin.[30] The antimicrobial activity of PS is extensively documented in the literature[6,26-28,31,36,49] as it offers low-cost therapy, simple manipulation procedures, and greater effectiveness. Hence, we designed a split mouth clinical and microbiologic study to compare the efficacy of PDT using curcumin as photosensitizer and curcumin as a gel to be used as an adjunct to scaling and root planing (SRP) with SRP alone in the treatment of chronic periodontitis.

MATERIALS AND METHODS

This clinical and microbiologic pilot study with a short duration of 3 months was carried out in the Department of Periodontics, Coorg Institute of Dental Sciences, Virajpet, India. The study protocol was reviewed and approved by the Institutional Review Board. The nature and purpose of the study and the recall protocol were explained to the subjects and a written consent was obtained before commencing the study. Patients diagnosed with chronic periodontitis aged between 35 and 55 years with at least one tooth with probing pocket depth (PPD) ≥5 mm in each quadrant were included in this study. Patients with periodontal treatment within the last 6 months, pregnancy, smoking, allergy to the dyes, and systemic diseases that could influence the outcome of therapy and ingestion of systemic antibiotics within the last 6 months were excluded from the study. Of 70 patients screened, 15 patients fulfilled the inclusion criteria. Sixty sites from these 15 subjects were selected for the study.

Scaling and root planing was carried out in a single session by a single researcher (PR) who is vastly experienced in the field and followed by randomized intervention protocol selected for each specified quadrant. The analysis and recording of clinical parameters and microbiologic findings were performed by another author (IS) blinded to the study to ensure unbiased analysis.

Collection of data

Upon screening and selecting the patients for study the following clinical examinations were done pre- and post-operatively at 1st and 3rd months. Plaque index (PI)[32] was recorded at baseline, 1st, and 3rd month to monitor the oral hygiene and motivation of the patients. Sulcus bleeding index (SBI),[33] PPD, and clinical attachment level (CAL) (standardized using an acrylic stent and measured using a UNC-15 probe, Hu-friedy, USA) were recorded at baseline and repeated after 3 months.

Treatment protocol

A proforma was used consisting of a brief case history, clinical examination, and recordings of clinical parameters at baseline, 1-month, and at the end of 3 months. Oral hygiene instructions for supragingival plaque control were given. Each quadrant was randomly assigned by principle researcher who was blinded about the subjects and quadrants to one of the following four treatment modalities.

- Quadrant 1 (Q1): SRP alone with an ultrasonic scaler (Satelec P5® SATELEC (India) Pvt., Ltd., Gandhinagar, India).
- Quadrant 2 (Q2): SRP + curcumin gel application for 5 min (Curenext oral gel® 10 mg/g from Abbott Healthcare Pvt., Ltd., Mumbai, India).
- Quadrant 3 (Q3): SRP + curcumin gel application for 5 min + irradiation with blue halogen curing light of wavelength 470 nm with intensity 620 mW/cm^2 for 5 min (curcumin PDT) on "0" day (Halogen Curing Light-Elipar™ 2500 from 3M™ ESPE™ St. Paul, MN 55144-1000, USA).
- Quadrant 4 (Q4): SRP + curcumin PDT on 0, 7th, and 21st day.

Plaque sampling for microbial analysis

After meticulous removal of supragingival plaque and calculus, the area was dried and isolated with cotton rolls saliva evacuators and then subgingival plaque samples were collected using sterile universal curettes (Hu-Friedy, USA) from each selected site (deepest pocket in each quadrant). Samples were collected at baseline, 1-month, and 3 months postoperatively. Samples were placed in sterile vials containing 0.5 ml of the reduced transport fluid and sent to the laboratory for microbial analysis.

Procedure for photodynamic therapy

Photodynamic therapy was done with a blue halogen curing light of wavelength 470 nm with intensity 620 mW/cm^2, a continuous mode for 5 min in quadrants 3 and 4. The photosensitizer was applied to the bottom of the periodontal pocket with the help of an applicator. After 5 min, the photosensitizer was rinsed with saline and exposed to diode laser on "0" day, which was repeated on 7th and 21st day for site in quadrant 4. The procedure was done using standard safety protocol including protective eyewear for the operator, patient, and the assistant. The patients were then instructed on routine brushing and rinsing with water. The patients were informed about the complications like feeling of pressure, pain or irritation in the area and were advised to have a soft diet. The patients were advised to report back to the department only if the irritation became intolerable.

Bacterial culturing

The microbial samples were assessed for *Aggregatibacter actinomycetemcomitans* (Aa) and black pigmented *bacteroids* (BPBs); *Porphyromonas gingivalis* and *Prevotella intermedia* by anaerobic bacterial culture method. For Aa, tryptic soy-serum-

Table 1: Patient demographics

Gender	*n*	Mean	SD
Male	7	49.85	3.670
Female	8	47.62	3.335

SD: Standard deviation

Table 2: Intra group comparison — clinical parameters

Quadrants	Intervals	PI		*P*	SBI		*P*	PPD		*P*	CAL		*P*
		Baseline	3rd month		Baseline	3rd month		Baseline	3rd month		Baseline	3rd month	
Q1	Mean	2.47	1.40		2.57	1.65		6.08	5.79		9.41	9.12	
	SD	0.122	0.186		0.186	0.232		0.214	0.198		0.505	0.458	
	Difference of mean Baseline to 3rd month	1.07		0.000#	0.92		0.000#	0.29		0.000	0.29		0.000#
Q2	Mean	2.49	1.48		2.80	1.56		6.13	5.63		9.63	9.16	
	SD	0.096	0.142		0.406	0.202		0.347	0.471		0.765	0.841	
	Difference of mean Baseline to 3rd month	1.01		0.000#	1.24		0.000#	0.5		0.000	0.47		0.000#
Q3	Mean	2.31	1.46		2.56	1.48		6.20	5.59		9.52	8.87	
	SD	0.241	0.159		0.175	0.199		0.253	0.527		0.578	0.711	
	Difference of mean Baseline to 3rd month	0.85		0.000#	1.08		0.000#	0.61		0.000	0.65		0.000#
Q4	Mean	2.44	1.42		2.73	1.20		6.21	5.40		9.39	8.63	
	SD	0.145	0.137		0.258	0.096		0.266	0.470		0.428	0.611	
	Difference of mean Baseline to 3rd month	1.02		0.000#	1.53		0.000#	0.81		0.000	0.76		0.000#

#*P* < 0.05 considered statistically significant. SD: Standard deviation, PI: Plaque index, SBI: Sulcus bleeding index, PPD: Probing pocket depth, CAL: Clinical attachment level

bacitracin-vancomycin (TSBV) media[34] was prepared with tryptic soy agar into which was added 10% serum, 1 mg/ml yeast extracts, 75 μg/ml bacitracin, and 5 μg/ml vancomycin. For BPBs, media[35] was prepared with blood agar base with 5% rabbit blood, 5 μg/ml hemin, 0.5 μg/ml menadione, 40 μg/ml kanamycin. The constituents were dispensed as per composition, weighed on an electronic balance and added to the required volume of distilled water. Upon sterilization and returning to room temperature, the previously weighed quantities of antibiotics and blood were mixed to the respective solutions. The media was quickly poured in petri plates under strict sterile conditions in the laminar air flow chamber and allowed to cool. The samples were dispersed by ultrasonication for 1 min in a vortex mixture. A portion of these samples taken in an inoculation loop of diameter 2 mm was plated, in triplicate, on plates containing BPB media and TSBV. All plates were incubated at 37°C for 72 h in an atmosphere of 5% CO_2 in an anaerobic jar. After completion of incubation, the plates were removed, and microorganisms were confirmed by colony morphology and the colony characteristics of the respective organism. The colony count was quantified using a manual counter. BPBs (*P. gingivalis* and *P. intermedia*) were identified as black pigmented colonies with β-hemolysis on blood agar. Aa was identified as minute, white translucent colonies on TSBV agar.

Statistical analysis

Quantitative analysis was done for all the clinical and microbiologic parameters by calculating mean and standard deviation. Collective data were analyzed by paired *t*-test for SBI on probing, PPD and CAL and microbial colony forming unit at baseline and postoperatively within the group. To compare the effect between the groups, Tukey's *post-hoc* test was used. $P < 0.05$ is considered to be statistically significant. Data were analyzed using statistical software SPSS (Statistical Package for Social Science, Version 13.0 in Microsoft Excel).

RESULTS

A total of 15 patients who were diagnosed with chronic periodontitis consisting of eight females (mean age 47.62 ± 3.34) and seven males (mean age 49.85 ± 3.67) were included in the study [Table 1].

When compared within the groups, statistically highly significant reduction in clinical parameters such as PI, SBI, PPD, and CAL was observed for each treatment modality with $P < 0.000$. There was a high reduction in SBI and PPD in Q4 compared to other quadrants with a mean difference of 1.53 and 0.81, respectively. Similarly, the treatment group shared better reduction in CAL after 3 months compared to all other groups with a highest mean difference of 0.76 mm gain in CAL [Table 2]. When compared for microbial parameters, there was statistically significant reduction with respect to Aa and BPB after 2 months and 3 months with the exception in Q1 between baseline to 1-month postoperatively [Table 3].

Table 3: Intra group comparison — microbial parameters

Quadrants	Intervals	Aa			*P*	BPB			*P*
		Baseline	1st month	3rd month		Baseline	1st month	3rd month	
Q1	Mean	137.00	121.40	108.13		133.00	112.86	101.53	
	SD	12.247	10.328	7.726		15.888	12.586	13.855	
	Difference of mean								
	Baseline-1st month		15.6		0.711		20.14		0.001#
	1st month-3rd month		12.87		0.001#		11.33		0.001#
	Baseline-3rd month		28.87		0.001#		31.47		0.001#
Q2	Mean	136.86	120.20	105.66		132.80	115.4	98.66	
	SD	8.667	9.488	9.700		10.199	10.595	13.51	
	Difference of mean								
	Baseline-1st month		16.66		0.001#		17.4		0.001#
	1st month-3rd month		14.54		0.001#		16.74		0.001#
	Baseline-3rd month		31.2		0.001#		34.14		0.001#
Q3	Mean	144.33	117.93	93.13		133.60	106.06	89.33	
	SD	9.044	10.700	9.395		11.242	9.527	8.014	
	Difference of mean								
	Baseline to 1st month		26.4		0.001#		27.54		0.001#
	1st month-3rd month		24.8		0.001#		16.73		0.001#
	Baseline-3rd month		51.2		0.001#		44.27		0.001#
Q4	Mean	140.53	109.13	81.66		134.20	103.06	81.20	
	SD	6.706	7.069	8.723		12.306	10.187	6.857	
	Difference of mean								
	Baseline-1st month		31.4		0.001#		31.14		0.001#
	1st month-3rd month		27.47		0.001#		21.86		0.001#
	Baseline-3rd month		58.87		0.001#		53.00		0.001#

#*P* < 0.05 considered statistically significant. SD: Standard deviation, BPB: Black pigmented *bacteroids*, Aa: *Aggregatibacter actinomycetemcomitans*

When the mean values were subjected for inter-group comparison using Mann–Whitney test, the baseline parameters between Q1 and Q2 were not statistically different, indicating unbiased random distribution of quadrants into each treatment modalities. Statistically significant reduction in both Aa and BPB was noticed at 3 months postoperative interval with a difference in mean of 2.47 and 2.87, respectively [Table 4]. This reduction in periodontal pathogens was also reflected in mean improvement in SBI scores in Q2 compared to Q1 ($P = 0.000$) [Table 4]. All other parameters were not statistically significant ($P > 0.05$).

On comparison between Q2 and Q3, the plaque scores had a significant difference at baseline hence further analysis was not considered for PI. Statistically highly significant improvement was observed in relation to BI, CFUs of Aa and BPB suggested that single application of PDT with curcumin as a PS gives better results than curcumin alone after SPP [Table 5].

Table 4: Intergroup comparison-sites 1 versus sites 2

Site 1 versus site 2						
Intervals	**Site**	***n***	**Mean**	**SD**	**Mean difference**	***P***
PI-baseline	1	15	2.47	0.122	0.02	0.585
	2	15	2.49	0.096		
PI-1-month	1	15	2.15	0.135	0.15	0.034*
	2	15	2.00	0.239		
PI-3 month	1	15	1.40	0.0186	0.08	0.404
	2	15	1.48	0.0142		
BI-baseline	1	15	2.57	0.186	0.23	0.440
	2	15	2.80	0.406		
BI-3 month	1	15	1.65	0.232	0.09	0.000#
	2	15	1.56	0.202		
PPD-baseline	1	15	6.08	0.214	0.05	0.521
	2	15	6.13	0.347		
PPD-3 months	1	15	5.79	0.198	0.16	0.116
	2	15	5.63	0.471		
CAL-baseline	1	15	9.41	0.505	0.22	0.657
	2	15	9.63	0.765		
CAL-3 months	1	15	9.12	0.458	0.04	0.117
	2	15	9.16	0.841		
Aa-baseline	1	15	137.00	12.247	0.14	0.107
	2	15	136.86	8.667		
Aa-1-month	1	15	121.40	10.328	1.2	0.003*
	2	15	120.20	9.488		
Aa-3 months	1	15	108.13	7.726	2.47	0.000#
	2	15	105.66	9.700		
BPB-baseline	1	15	133.00	15.888	0.2	0.990
	2	15	132.80	10.199		
BPB-1-month	1	15	112.86	12.586	2.54	0.009*
	2	15	115.40	10.595		
BPB-3 month	1	15	101.53	13.855	2.87	0.000#
	2	15	98.66	13.510		

*Mann-Whitney test

*Statistically significant, #Statistically highly significant. BPB: Black pigmented *bacteroids*, Aa: *Aggregatibacter actinomycetemcomitans*, PPD: Probing pocket depth, CAL: Clinical attachment level, PI: Plaque index, SD: Standard deviation

In addition, further analysis was done to determine the added benefits of multiple applications of PDT over single application. Interestingly, the results showed better improvements in terms of CFUs of Aa and BPB with a $P = 0.000$ [Table 6] when compared to all the quadrants at each interval, which resulted in a decrease in anaerobic microbial CFU with a concomitant decrease in SBI scores.

DISCUSSION

The treatment of chronic periodontitis has always presented a challenge for clinicians due to nonavailability of established protocols and guidelines for the efficient control of the disease.[36] Various treatment measures include the conventional mechanical nonsurgical and surgical treatment methods along with various adjunctive anti-infectious therapeutics including the use of disinfectants and antibiotics.[37-41] Disadvantages of chemotherapeutic treatment are possible bacterial resistances and the occurrence of side effects following systemic application.[42] Although nonsurgical sub-gingival debridement is effective, certain pathogens such as *Aa* and *P. gingivalis* are particularly resistant to the effects of sub-gingival debridement due to their ability to invade underlying connective tissues.[43,44]

Table 5: Intergroup comparison-site 2 versus site 3

Site 2 versus site 3						
Intervals	**Site**	***n***	**Mean**	**SD**	**Mean difference**	***P***
PI-baseline	Values not calculated due to statistically significant values of quadrant 3 at baseline					
PI-1-month						
PI-3 month						
BI-baseline	2	15	2.80	0.406	0.04	0.440
	3	15	2.56	0.175		
BI-3 month	2	15	1.56	0.202	0.08	0.000#
	3	15	1.48	0.199		
PPD-baseline	2	15	6.13	0.347	0.07	0.521
	3	15	6.20	0.253		
PPD-3 months	2	15	5.63	0.471	0.04	0.116
	3	15	5.59	0.527		
CAL-baseline	2	15	9.63	0.765	0.11	0.657
	3	15	9.52	0.578		
CAL-3 months	2	15	9.16	0.841	0.29	0.117
	3	15	8.87	0.711		
Aa-baseline	2	15	136.86	8.667	7.47	0.107
	3	15	144.33	9.044		
Aa-1-month	2	15	120.20	9.488	2.27	0.003*
	3	15	117.93	10.700		
Aa-3 months	2	15	105.66	9.700	12.53	0.000#
	3	15	93.13	9.395		
BPB-baseline	2	15	132.80	10.199	0.8	0.990
	3	15	133.60	11.242		
BPB-1-month	2	15	115.40	10.595	9.34	0.009*
	3	15	106.06	9.527		
BPB-3 months	2	15	98.66	13.510	9.33	0.000#
	3	15	89.33	8.014		

*Mann–Whitney U-test

*Statistically significant, #Statistically highly significant. BPB: Black pigmented *bacteroids*, Aa: *Aggregatibacter actinomycetemcomitans*, PPD: Probing pocket depth, CAL: Clinical attachment level, PI: Plaque index, SD: Standard deviation

Table 6: Intergroup comparison – site 3 versus site 4

Site 3 versus site 4						
Intervals	**Site**	***n***	**Mean**	**SD**	**Mean difference**	***P***
PI-baseline	Values not calculated due to statistically significant values of quadrant 3 at baseline					
PI-1-month						
PI-3 month						
BI-baseline	3	15	2.56	0.175	0.17	0.440
	4	15	2.73	0.258		
BI-3 month	3	15	1.48	0.199	0.28	0.000#
	4	15	1.20	0.096		
PPD-baseline	3	15	6.20	0.253	0.01	0.521
	4	15	6.21	0.266		
PPD-3 months	3	15	5.59	0.527	0.19	0.116
	4	15	5.40	0.470		
CAL-baseline	3	15	9.52	0.578	0.13	0.657
	4	15	9.39	0.428		
CAL-3 months	3	15	8.87	0.711	0.24	0.117
	4	15	8.63	0.611		
Aa-baseline	3	15	144.33	9.044	3.8	0.107
	4	15	140.53	6.706		
Aa-1-month	3	15	117.93	10.700	8.8	0.003*
	4	15	109.13	7.069		
Aa-3 months	3	15	93.13	9.395	11.47	0.000#
	4	15	81.66	8.723		
BPB-baseline	3	15	133.60	11.242	0.6	0.990
	4	15	134.20	12.306		
BPB-1-month	3	15	106.06	9.527	3.00	0.009*
	4	15	103.06	10.187		
BPB-3 month	3	15	89.33	8.014	8.13	0.000#
	4	15	81.20	6.857		
*Mann–Whitney U-test						

*Statistically significant, #Statistically highly significant. BPB: Black pigmented *bacteroids*, Aa: *Aggregatibacter actinomycetemcomitans*, PPD: Probing pocket depth, CAL: Clinical attachment level, PI: Plaque index, SD: Standard deviation

Table 7: Percentage reduction in microbial parameters after 3 months

Quadrants	Aa	BPB
Q1	21.0	23.0
Q2	22.8	25.7
Q3	35.4	33.1
Q4	41.9	39.5

BPB: Black pigmented *bacteroids*, Aa: *Aggregatibacter actinomycetemcomitans*

A new treatment possibility obviating these disadvantages is a PDT, which combines the application of a PS dye and irradiation with light of appropriate wavelength. PDT application has an adjunctive benefit at sites with difficult to access for example deep periodontal pockets, furcations, and root concavities.

Curcumin is effective in treating periodontal diseases.[45] Most studies evaluating the efficacy of PDT on oral bacteria have used toluidine blue O (TBO) and methylene blue as PS, followed by irradiation with a red light emitting diode light.[46-51] Neither TBO dye nor light alone has any significant antibacterial effect indicating the need for dye-light conjugation to ensure the effectiveness of PDT. In this study, the halogen curing light (470 nm) with an intensity of 620 mW/cm^2 was used together with curcumin gel with a concentration of 10 mg/g. The dyes work as optical absorption agent which is activated by irradiation with light of a specific wavelength, resulting in the generation of cytotoxic species, including singlet oxygen and free radicals, which exert a bactericidal effect but that are not toxic to host cells.[52,53] Our study suggests that curcumin as local drug adjunct to SRP is effective in reducing gingival bleeding and periodontal pathogens like Aa and BPB, which is further supports previous studies[54-57] reporting comparable anti-inflammatory effect of curcumin and/or chlorhexidine mouthwash. Curcumin suppresses the growth of *Streptococcus*, *Staphylococcus, Lactobacillus, Helicobacter pylori,* etc.[58]. Similarly, the antibacterial effect of curcumin was also equally effective in reducing *Pg* as tested by *N*-benzoyl-*d* L-arginine-2-naphthylamide test.[55] Hence, to evaluate its effect on periodontal pathogenic Gram-negative species as well as its effect on other clinical parameters, this study was carried out.

Our study also evaluated the effectiveness of curcumin as PS in PDT using a light with a specific wavelength. There is a dearth of knowledge in this field with only two studies assessing the anti-bacterial effects of curcumin as PS in PDT against *Streptococcus mutans* and *Lactobacillus acidophilus*[58] and on full mouth disinfection.[60] To the best of our knowledge, no study has reported using curcumin gel as photosensitizer and studied the effect on anaerobic periodontal pathogens such as Aa and black pigment-producing bacteria (BPB). Our study showed a significant effect of PDT using curcumin gel as PS in the reduction of periodontal pathogens when compared to SRP alone and sub-gingival curcumin gel without light activation. Interestingly, the antibacterial effects almost doubled when curcumin gel was irradiated with light of 470 nm wavelength and 620 mW/cm^2 power intensity [Table 7]. These results were improved when the multiple applications of PDT was performed. The curcumin attaches to the bacterial cell wall of periodontal pathogens and when irradiated with light of specific wavelength produces ROS, which can destroy the pathogens in the immediate vicinity.[59] Although the study showed statistically significant reduction in bacterial colonies evident from reduction of sites with SBI on probing, the other clinical parameters such as PPD and CAL failed to show improvements which can be attributed to the short duration of the study (3 months) and small sample size, and is in contrast to previous study[61] reporting improvement in all the clinical parameters after 45 days of treatment. Hence, future studies with large sample size and longer duration are necessary to confirm the effects of curcumin gel in periodontal therapy.

CONCLUSION

Within the limitations of the study, it can be concluded that adjunctive use of curcumin gel as a local sub-gingival drug with SRP has an antibacterial action on periodontal pathogens such as Aa, *Pg*, and *Pi*. Further irradiation with light of 470 nm wavelength and a power intensity of 620 mW/cm^2 potentiates the benefits of curcumin. The effects were further enhanced by multiple applications of PDT.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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